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THE PLANT DISEASE REPORTER

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THE PLANT DISEASE SURVEY

Division of Mycology and Disease Survey

BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING

AGRICULTURAL RESEARCH ADMINISTRATION

UNITED STATES DEPARTMENT OF AGRICULTURE

SUPPLEMENT 180

CANTALOUPE MOSAIC INVESTIGATIONS IN THE IMPERIAL VALLEY

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Supplement 180 January 30, 1949

The Plant Disease Reporter is issued as a service to plant pathologists throughout the United States. It contains reports, summaries, observations, and comments submitted voluntarily by qualified observers. These reports often are in the form of suggestions, queries, and opinions, frequently purely tentative, offered for consideration or discussion rather than as matters of established fact. In accepting and publishing this material the Division of Mycology and Disease Survey serves merely as an informational clearing house. It does not assume responsibility for the subject matter.

PLANT DISEASE REPORTER SUPPLEMENT

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THE PLANT DISEASE SURVEY
DIVISION OF MYCOLOGY AND DISEASE SURVEY

Plant Industry Station Beltsville, Maryland

CANTALOUPE MOSAIC INVESTIGATIONS IN THE IMPERIAL VALLEY

Plant Disease Reporter
Supplement 180 January 30
1949

FOREWORD

The University of California and the U. S. Department of Agriculture, in cooperation with the Cantaloupe Pest Control Committee of the Imperial Valley, have undertaken a joint project designed to investigate all phases of the cantaloupe mosaic disease. This disease has caused damaging losses to the cantaloupe growers of the Imperial Valley during the past three years and threatens to become a major disease in other producing areas of the Southwest. The results of preliminary investigations by staff members assigned to the project are reported in this Supplement. These reports were presented at a meeting of the Imperial Valley Cantaloupe Pest Control Committee, in Brawley, California, June 16, 1948.

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THE CANTALOUPE MOSAIC DISEASE

John T. Middleton

Cantaloupe mosaic is a virus disease affecting most cultivated melon varieties as well as some other cultivated cucurbits. The disease may be caused by any one of a number of strains of cucumber viruses within the families Cucumber 1 and Cucumber 2. As yet it is not possible to determine exactly which virus is most prevalent, but it would appear that the squash mosaic virus is predominant.

The most conspicuous symptoms of the disease are the light green and dark green mottling of the leaves, usually followed by leaf reduction, a mottling of fruits, and the failure of most melon varieties to set fruit or mature them in normal fashion.

Information concerning the host range of the virus is limited, but apparently a number of native plants are reservoirs for the virus. The cantaloupe mosaic virus is known to occur in Cucurbita foetidissima H.B.K. and C. palmata Wats., both native to the Colorado Desert. In addition to the native flora, the virus is found commonly in squash, and it is believed that squash is the prime source of the virus for the cantaloupe mosaic disease. The virus may be spread mechanically, may be transmitted by the seeds of certain plants, and is generally distributed by means of insect vectors. At present it is known that two species of cucumber beetles [Diabrotica undecimpunctata Mann. and Acalymma trivittata (Mann.)] and three species of aphids [Aphis gossypii Glov., Macrosiphum pisi (Kalt.), and Myzus persicae (Sulz.)] are vectors. Control of the disease is based on the elimination of the virus or the vectors, or the production of resistant varieties.

Although disease-free seed can be produced and has been generally used, the planting of virus-free seed is not the solution of the problem; but is an important aspect to be considered. The abundant sources of virus in squash, melon, and other cultivated cucurbits, as well as the native sources of the virus, make it impossible to have host-free periods which would effectively control melon mosaic.

During the past melon season (1947-48), through the cooperation of the University of California, Division of Entomology, Riverside, extensive trials were conducted, which were directed towards the control of the insect vectors. Repeated applications of insecticides at appropriate times to melons failed to reduce the amount of mosaic in melons. The principal source of the aphids appears to be the sugar beet. The sugar beet does not provide much, if any, virus inoculum. The increased occurrence of melon mosaic in Imperial Valley may possibly be correlated with the present increase in sugar beet acreage.

There is considerable evidence that fairly satisfactory yields of melons may be obtained despite the presence of the virus, if the crop is carefully handled as to irrigation and fertilization. Plantings 100 percent infected were noted that gave satisfactory yields. It was determined that these fields received more frequent irrigations than similar adjacent fields which yielded poorly, and that the better yielding fields had received small but regular applications of nitrogen.

Vector control is not recommended. In the absence of any satisfactory resistant melon variety, it is felt that fair crop yields may be expected if attention is focused upon proper horticultural practices for the best growth of cantaloupes.

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VECTORS CONCERNED IN TRANSMISSION OF CANTALOUPE MOSAIC IN THE IMPERIAL VALLEY

J. E. Swift

The purpose of this study is to determine specifically which aphids and cucumber beetles are the transmitting agents for the cantaloupe mosaic virus complex. It was also hoped that through vector transmission studies sources of the viruses could be determined.

Aphids and cucumber beetles were secured from various weeds and crops, and also free-flying ones in the air. These insects were then placed on disease-free squash or melon plants grown in a greenhouse designed to prevent any possible outside or chance infection.

Five cucumber beetles (four Acalymma trivittata (Mann.) and one Diabrotica undecimpunctata Mann.) were collected; all failed to transmit the virus in this test.

Aphids used in this study were collected from alfalfa, bamboo or cane, barley, sourclover, lambsquarters, malva, healthy-appearing melons, infected melons, sowthistle, infected squash, sugar beet, sunflower, and wild beet; also free-flying insects were used, including those caught in the air and placed on diseased plants before caging and those caught in the air and caged upon a healthy plant immediately. The plants mentioned above were selected because they maintained large aphid populations and thereby became suspects as possible hosts for the viruses.

The green peach aphid, Myzus persicae (Sulz.), comprised 61.3 percent of the aphids used as possible vectors. The pea aphid, Macrosiphum pisi (Kalt.), and potato aphid, M. solanifolii (Ashm.), constituted 16.3 percent of the total number. Representatives of other species were used in much smaller numbers.

From 11,643 aphids used in making 187 inoculations 10 positive transmissions resulted. Only the green peach aphid and the melon aphid, Aphis gossypii Glov., transmitted the virus. The melon aphid accounted for two of the transmissions. Both of these were effected by collecting apterous melon aphids from infected squash plants and placing them on healthy melon plants. Eight transmissions were made by the green peach aphid. Six of these transfers were by winged aphids, the other two by both winged and apterous aphids in the same culture. In these eight transmissions by the green peach aphid, three were accounted for by utilizing either winged or apterous aphids collected from infected squash or melons; three transmissions were obtained by collecting free-flying aphids and then feeding them on infected squash before caging

them on healthy melon plants; two transmissions were secured by collecting free-flying aphids and placing them directly on healthy melon plants.

No transmissions were effected when fewer than 15 aphids were used per inoculation. It seems possible that several feedings by viruliferous aphids are necessary before the virus is transmitted and symptoms appear. This hypothesis gains support from information available on aphid populations in the Imperial Valley and their feeding habits.

No virus transmissions were secured from plants other than infected squash or melons. Although the sugar beet is a known host for the cucumber mosaic virus and numerous tests were made using a few to several hundred aphids from sugar beet plants, no virus infections on melons resulted. Likewise, melons remained virus-free following transfers of aphids from alfalfa, bamboo, barley, wild beet, sourclover, sunflower, and sowthistle.

In summary it may be stated that: The green peach and melon aphids present in the Imperial Valley can transmit the cantaloupe mosaic virus. The green peach aphid was by far the most common species and brought about the greatest number of virus transmissions to melon. Transmissions of the virus were obtained only with aphids collected or fed upon infected squash or melons and with free-flying aphids collected in flight. No transmissions were effected with aphids taken from alfalfa, bamboo, barley, sugar beet, wild beet, sourclover, lambsquarters, malva, or weeds in general.

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VECTORS OF CANTALOUPE MOSAIC AND THEIR TRANSMISSION HABITS

J. B. Kendrick, Jr.

Preliminary work has been directed towards establishing the identity of vectors and their requirements for the spread of the virus or viruses that cause cantaloupe mosaic. It has been shown conclusively this year that the melon aphid and the green peach aphid, Aphis gossypii Glov. and Myzus persicae (Sulz.), respectively, are vectors of this disease when used in populations of fifteen or more. Although Myzus persicae appears to be the principal vector, evidence indicates that other aphid species are concerned. It is the purpose of this investigation to test the numerous aphid species common in the Colorado Desert for their ability to act as vectors for this disease, and to ascertain their transmission habits for each of the viruses within the complex.

Winged, apterous, and nymph forms of the green peach aphid, Myzus persicae, corn aphid, Aphis maidis Fitch, and the pea aphid, Macrosiphum pisi (Kalt.), have been studied in the following manner. Cultures of non-viruliferous aphids have been made viruliferous by feeding once on a Honeydew plant, Cucumis melo L., infected with one of the viruses of the cantaloupe mosaic complex. They were then transferred to healthy susceptible cantaloupe seedlings, Cucumis melo L. var. cantalupensis Naud., in such a manner as to show whether one aphid feeding once could transmit the disease, and whether it could infect four healthy plants on four successive feedings. Preliminary evidence indicates that more than one aphid is necessary for such infection. The same procedure was followed with two aphids feeding once on one plant, three aphids feeding once, and four aphids feeding once. They were transferred again so that two, three, and four aphids, respectively, had their second feedings on a healthy plant, third feedings on another healthy plant, and fourth on still another healthy plant. In these trials the winged, apterous, and nymph forms of the corn aphid, the pea aphid, and the green peach aphid showed no ability to transmit the virus in such limited numbers. Thus, at least four aphids from these species having fed once on an infected host are apparently not able to transmit this virus. This study is being carried forward to find out the minimum requirements for transmission.

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APHID FLIGHTS IN RELATION TO CANTALOUPE MOSAIC

R. C. Dickson

The increased severity of cantaloupe mosaic infection in the Imperial Valley in recent years is apparently related to an increase in the spring aphid population. This increased aphid population coincided with:

1. A general increase in the severity of aphid infestations over the United States, which is believed to have been caused by the widespread use of the new synthetic organic insecticides, particularly DDT and benzene hexachloride.

2. The increase in sugar beet acreage in the Valley.

Small aphid flights began shortly before March 1. These were mostly of the corn aphid, Aphis maidis Fitch, from barley, and probably had no effect on the melons, which were still covered with cap protectors at that time. The green peach aphid, Myzus persicae (Sulz.), soon became the most numerous species and the flights increased steadily in severity. The green peach aphid breeds on lettuce, beets, and various weeds, particularly Malva and Chenopodium.

Catches on nine sets of sticky-board traps in the Valley rose from 2,000 the first week of March to 28,000 the first week of April, the percentage of green peach aphids rising from 50 to 90. The catch then dropped off, again reaching 2,000 during the last week of April.

During the height of the flights, 90 percent of the aphids flying were the green peach aphid and possibly 90 percent of these came from the sugar beet fields. The melon aphid, Aphis gossypii Glov., population was very low at this time, some 20 other species being more numerous.

Sticky-board traps in the desert caught comparatively few aphids, which shows that the aphids in the Valley originated in the Valley and probably did not travel in large numbers for more than five or six miles.

During winds the aphids do not fly, winged aphids remaining on the plants until the wind dies down. After the wind has abated and conditions become right, they take off in swarms and move across the country. Flight appears to be at random, and the insects are carried by the air drift which usually amounts to one to two miles per hour.

Attempts to measure the size of aphid flights gave figures for a good flight of some 40,000,000 aphids passing a mile front each hour.

Records of aphid activity during flights showed that when aphids land-

ed they started to feed almost immediately, fed for an average of some 40 seconds in one to three feeding periods, then walked to the tip of a leaf and took off. They apparently flew a short distance, again landed, and repeated the feeding performance. In this way they worked themselves across the country, each aphid feeding for short periods on a considerable number of plants. Some 50 aphids per minute per melon hill were observed to light during a good flight. The same number left the hill during the same period so that there never was a great concentration of aphids on the plants. The winged aphids that are seen resting on melon plants when no flight is on are simply those that were caught there when conditions became unfavorable for flight, because of wind, darkness, or change of temperature. It is probable that if the green peach aphid preferred to feed on melon plants it would be less migratory and hence not so efficient in spreading the mosaic.

There are practically no sugar beets in the Blythe and Yuma areas. Considerable melon mosaic occurs in these areas in certain years, but less than in the Imperial Valley. Limited observations made in these two localities indicated that the green peach aphid was the most common species, but it did not occur in anything like the numbers found in the Imperial Valley. It was found breeding in good numbers on lettuce (early in the season) and on Malva and Chenopodium. Aphids appeared to be a bit more common at Yuma than at Blythe.

Small-scale experiments were conducted in dusting cantaloupe plants with various chemicals to see if they acted as repellents. Various aromatic compounds and essential oils were used as were certain compounds known to be repellent to other insects. While at least one of these, tetramethyl thiuramdisulfide, showed some measure of repellency, none were effective in reducing the mosaic infection in the plots. All plots were 100 percent infected with mosaic.

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LARGE-SCALE INSECTICIDE TESTS

L. D. Anderson

The report on repellents shows that some of the materials tested as repellents had some effect on the aphids but did not reduce the amount of cantaloupe mosaic. The same story was found to be true in the large-scale insecticide tests.

Tests were made on the S. A. Gerrard ranch north of Westmoreland, on the American Fruit Growers ranch west of Brawley, and on the Fred. R. Bright ranch in the Mount Signal district. All insecticide applications were made by airplane, a Piper Club being used for the first application on the Gerrard ranch and the third application on the Bright ranch, and a Stearman plane for all other applications. Three applications were made on each ranch; the interval between applications varied from 8 to 13 days depending on weather conditions. The first applications were made as soon as possible after the cap protectors were removed from the cantaloupes. Each insecticide was applied to 10-acre blocks on each ranch. The plane made from 8 to 14, with an average of 10, passes to cover each plot each time. The plane flew at an altitude of 8 to 14 feet above the vines. All applications were made under fairly good weather conditions, and in the evening, except the second and third applications on the Gerrard ranch which were made in the morning. Heavy aphid flights occurred during the first and second applications on the Gerrard and the American Fruit Growers ranches and the second application on the Bright ranch. A light flight occurred while the first application was being made on the Bright ranch; slight to no flights occurred while the third application was being made on each ranch.

The insecticide dust mixtures used were the following:

DDT 1% plus Velsicol AR60 2% (40 pounds per acre)
DDT 5% (30 pounds per acre)
Benzene hexachloride (1% gamma isomer) (20 pounds per acre)
Nicotine 4% (30 pounds per acre)
Parathion 1% (30 pounds per acre; used only on Gerrard ranch)

The third application of benzene hexachloride was omitted on the Gerrard and the American Fruit Growers ranches because of foliage injury by this material.

None of the insecticides tested appeared to affect the aphids even when the materials were being applied during heavy flights, and none of the treatments reduced the mosaic infection.

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BREEDING MUSKMELONS FOR RESISTANCE TO MOSAIC

G. W. Bohn[1]

The United States Department of Agriculture, the University of California, and the Cantaloupe Pest Control Committee of California have jointly attacked the problem of breeding muskmelons for resistance to the more important mosaic diseases. There is no good, mosaic-resistant muskmelon ready for release. Some progress has been made, however, and it seems worthwhile to summarize the breeding problem at this time.

A brief summary of the development of powdery mildew-resistant cantaloupes may serve as a basis for comparison. It took a relatively short time, ten years, to develop Powdery Mildew Resistant Cantaloupe No. 45. This variety, introduced in 1936, has a single, dominant genetic factor for resistance to strain 1 of Erysiphe cichoracearum DC., the fungus that causes muskmelon powdery mildew. The breeding work was, therefore, relatively simple.

Considerably longer, 16, 18, and 18 years, respectively, was required to develop Powdery Mildew Resistant Cantaloupes No. 5, No. 6, and No. 7. These varieties have several genetic factors for resistance to powdery mildew as well as numerous genetic factors governing yield, size, shape, quality, and the other factors that are essential to make a good commercial cantaloupe. Thus the breeding program became more complicated, and the time required to combine all of the essential characters into a single line was, therefore, longer.

Lines of cantaloupes with powdery mildew resistance more potent than that possessed by No. 5, No. 6, and No. 7 are in existence. These lines have greater numbers of factors governing resistance than the varieties mentioned and have, therefore, required a longer time for development. Several of these lines are now ready for release, so far as powdery mildew is concerned, after about 25 years of diligent work. However, mosaic has complicated the problem. Releases will be made when there is reason to believe that any line is better than those that are already on the market.

The mosaic resistance breeding program is about at the stage at which the powdery mildew breeding program was in 1927 or 1928. In the case of cantaloupe mosaic there is more than one disease; certainly two, possibly several. It is of paramount importance that these should be separated. In addition to obtaining resistance to virus diseases, powdery

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[1]The opportunity is taken here to acknowledge the assistance of Mr. A. H. Hovley, agent, U. S. Department of Agriculture, who was in charge of the cultural operations, and of Mr. G. A. Sanderson, scientific aid, who prepared the photographs.

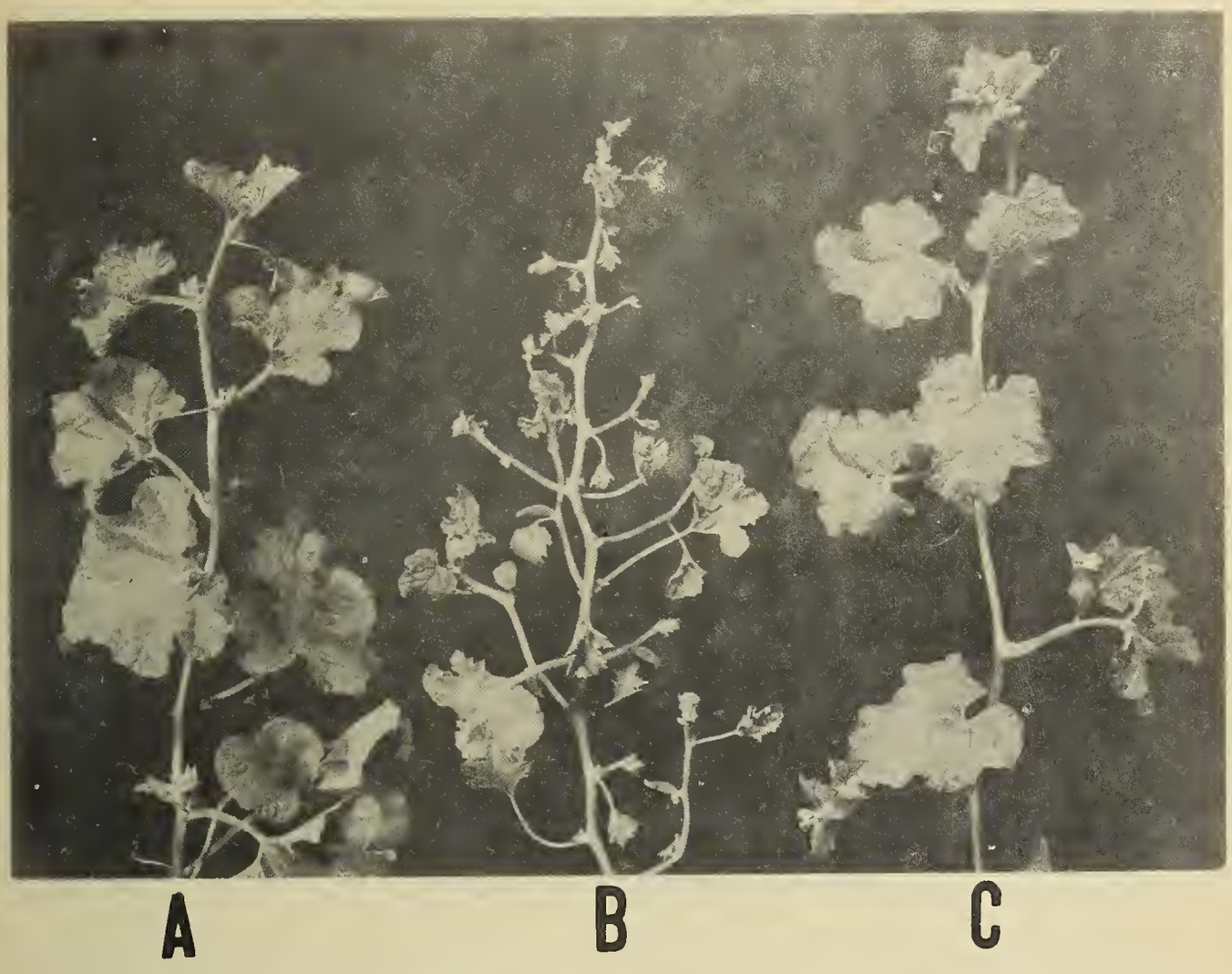

Figure 1. Shoots of muskmelons naturally infected with virus in the Imperial Valley, 1948. A — Mildly affected shoot of Cucumis melo var. chito P.I. 157076. B -- Severely affected shoot of C. melo var. reticulatus commercial variety Seed Breeders' Hales Best. C -- Moderately affected shoot of the commercial variety Ferry Morse's Sulfur Resistant V-1.

mildew resistance must be maintained as well as all of the other characters that are required to make a suitable commercial muskmelon.

The several distinct types of reaction of the muskmelon to the virus that might be utilized in a breeding program are: (1) Immunity -- the ability of the plant to prevent the virus from becoming established; (2) True resistance -- the ability of the plant to combat the virus and reduce its activity or abundance or both; (3) Tolerance -- the ability of the plant to tolerate the virus and to thrive although the development of the virus is also abundant; (4) Klendusity -- the ability of the plant to escape infection by the virus although it is very susceptible to the disease if infection does occur.

Of the four types of response, immunity is to be preferred. Immunity to muskmelon viruses has not been found in Cucumis melo. However, large numbers of importations from foreign countries are still being tested.

Klendusity probably has little value because of the overwhelming population of insect vectors. The nature of the aphids' habits and their abundance during migration make it very unlikely that any kind of muskmelon plant, dusted or not dusted, will have much chance to escape infection.

Resistance and tolerance remain to be considered. These are not so desirable as immunity or complete prevention of the disease by other methods; however, they are valuable. The value of resistance is demonstrated by the success of Powdery Mildew Resistant Cantaloupes No. 45, No. 5, No. 6, and No. 7 in controlling powdery mildew. The value of tolerance has been observed by most muskmelon growers who have suffered losses from mosaic. In general, cantaloupes are more tolerant than Honeydews and Honeyballs and mosaic losses have been less severe in No. 45, No. 5, No. 6, and Ferry-Morse's Sulfur Resistant V-1 than in Honeydews and Honeyballs. Similarly, Ferry-Morse's Sulfur Resistant V-1 is slightly more tolerant than No. 5 or No. 6, but it is probably not so tolerant of heat and is susceptible to powdery mildew.

The difference between true resistance and tolerance is an important one, both theoretically and practically for use in disease control. However, resistance grades into tolerance and it is often difficult to distinguish one from the other. In plant breeding both are usually measured by the intensity of symptoms developed in the host plant. To avoid confusion, the word tolerance will be used to describe the plant material on hand until resistance is proven. It should be understood, however, that there is no proof, at present, to establish whether these plants are truly resistant or merely tolerant.

Conditions were excellent for a natural epiphytotic of cantaloupe

mosaic in the experimental plots near Brawley, California, in 1947 and 1948. No plant in the 5-acre planting escaped infection in either year. In any one plant the symptoms increased to a maximum, then usually subsided. Some plants showed very extreme symptoms and did not recover; some plants recovered slightly; still others developed relatively mild symptoms and exhibited marked ability to recover. Plants that showed the mildest symptoms when symptoms were at their maximum severity and showed the greatest degree of recovery were considered to have possible value in the breeding program.

All of the plants in an inbred line or in a variety or a foreign plant introduction usually showed the same intensity of symptoms and the same degree of recovery. The range in intensity of symptoms in cantaloupes is shown in Fig. 1, A, B, and C. Seed Breeders' Hales Best, Fig. 1, B, developed extreme symptoms with severe leaf mottling and distortion and suppression of leaf growth. The suppression of leaf growth without a corresponding suppression of stem growth and flower bud initiation produced the prominent symptom of leafless ("shoestring") shoots. The flowers on such plants were usually dwarfed and malformed, and frequently failed to develop fully. Those that did develop usually produced poor pollen, and the perfect or the pistillate flowers often failed to set fruits following controlled or natural pollination. Fruits that did develop were small, malformed, mosaic-mottled, and produced poor net; they were low in quality and often sunscalded. The plants showed very little ability to recover.

Ferry-Morse's Sulfur Resistant V-1 produced some shoots with severely stunted leaves, but the symptoms were often limited to moderate chlorosis and mild distortion of leaf margins, Fig. 1, C. The flowers on such plants usually matured but were occasionally malformed in some degree. The perfect and pistillate flowers set fruits fairly readily following self-pollination and set nearly normal crops of fruits following natural pollination. Such plants recovered from extreme symptom expression rapidly and grew with considerable vigor. Late symptoms were usually limited to mild mosaic chlorosis of leaves and young fruits. The fruits were usually nearly normal in size, shape, net, flavor, and soluble solids.

A few collections of the lemon cucumber (Cucumis melo var. chito Morr., P.I.[1] 143647, 157076, and 157079 to 157085 inclusive) seemed to be slightly more tolerant than any of the commercial varieties. Other collections of this variety, including one purchased on the market, were less tolerant. Symptoms in these plants were usually limited to mild or moderate mottling of the leaves, Fig. 1, A. The leaves were rarely stunted or malformed and the fruits, which are normally nonnetted, were apparently

[1] P.I. is used herein to indicate plant introductions imported through the Division of Plant Exploration or its precursors.

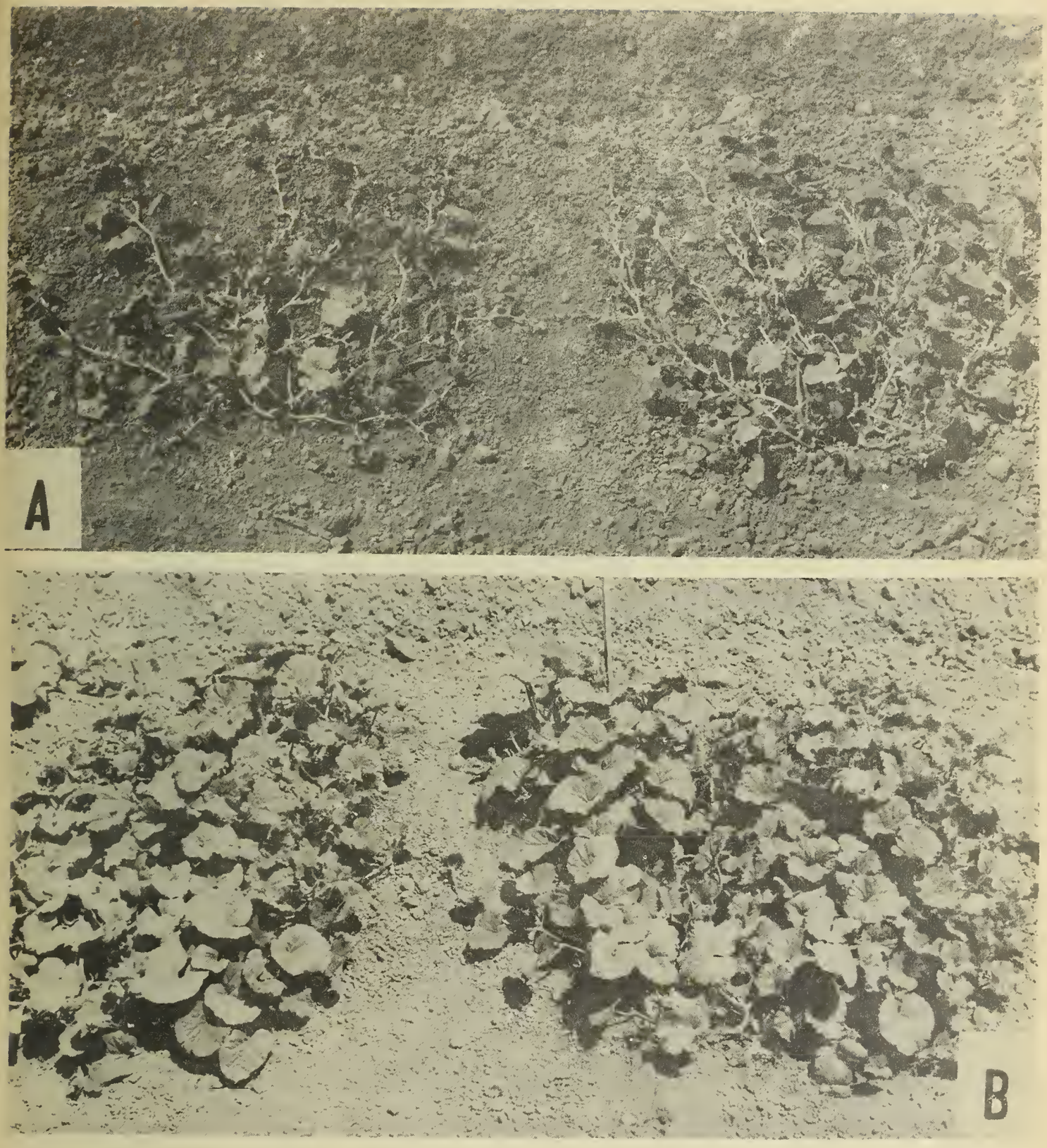

Figure 2. Muskmelon plants naturally infected with virus in the field, Brawley, California, 1948. A -- Four severely affected plants in two hills of the commercial variety Melogold. B — Four mildly affected plants in two hills of an inbred powdery mildew resistant line similar to Melogold.

Figure 3. A severely affected plant and a mildly affected plant in a single hill of the French variety Charentais.

normal.

Most of the commercial varieties and powdery mildew resistant lines were similar to Seed Breeders' Hales Best, Fig. 1, B, or Ferry Morse's Sulfur Resistant V-1, Fig. 1, C. A few were similar to the resistant collections of Cucumis melo var. chito, Fig. 1, A. One of these, similar to the variety Melogold in fruit characters, is compared with that variety in Figure 2, A and B.

In addition to differences between lines, differences were occasionally noted within lines. A mildly affected plant and a severely affected plant in a single hill of the French variety Charentais are shown in Fig. 3. Similar differences among plants within a line occurred in material inoculated in the seedling stage in the greenhouse at the Torrey Pines Station.

The variation in reaction to mosaic among different lines and among plants within lines may have been caused by differences in the plants, in the virus or viruses, or in some other condition. Work has been initiated to determine the nature of this variation. If it is genetic tolerance it will be utilized in the breeding program. If we can combine tolerance from several different sources it is possible that we can produce a good, mosaic-tolerant muskmelon variety.

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SUGGESTIONS FOR FUTURE RESEARCH

Thomas W. Whitaker

In the light of the new information presented in the previous reports it seems that there are at least three fields of research that can be profitably explored in the future. These fall naturally into separate categories.

1. Entomological approach. Is it possible to do something about controlling aphids in sugar beet fields, that will prevent the terrific "build-up" and, later on, the infecting flight through the cantaloupe fields? In order to produce this information, some large-scale experimentation will surely be required. It will involve careful planning by the entomologists and plant pathologists, combined with the cooperation of the sugar beet and cantaloupe growers. In any event the results should be worth while if they do nothing more than indicate that some control of the aphid population can be established by appropriate treatment of sugar beet fields.

2. Horticultural. The second category, which for lack of a better term may be called the horticultural, is much in need of investigation. For example, there is the question of soil moisture; is it advisable, after infection, to stabilize the soil moisture content at a high or a low level? Apparently there is no precise or reliable information at hand to answer this question, and the chances are good that it would be exceedingly helpful if we did know about this important factor.

Likewise the effects of various fertilization practices upon symptoms of the disease have not been investigated. It is not unlikely that the severity of the disease can be alleviated to a certain extent by some variation in the kind and quantity of the nutrient supply.

3. Plant breeding. The work reported by G. W. Bohn points very strongly to the possibility that resistance to the disease is heritable. There are several indications here and there among the breeding stocks and in some of the recent accessions that indicate such may be the case. It appears to be worth while to attempt to combine the resistance exhibited by various lines into a single group of progenies. It is not unlikely that if this could be done and the characters for resistance later incorporated into commercially acceptable types, satisfactory crops of good quality could be produced. This program would evidently require several years' work to bring it to fruition, and even then there is no definite assurance it would be successful.

There is one phase of the plant breeding approach that is perhaps not being pursued with as much vigor as its importance deserves -- the

plant exploration angle. It would be worth many thousands of dollars to the industry if a gene or genes carrying resistance or immunity to the mosaic disease could be imported into this country. If such material could be secured, the synthesis of a good commercial melon would be a relatively simple job. At the moment the Division of Plant Exploration and Introduction, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture, has a plant explorer in the field in India; but India is a large territory for one man to cover during a limited collecting season. It is possible that much more could be accomplished by concentrated collecting in the most promising localities.

There is one category that seems to have been omitted for the moment, and that is the pathological. It is very important to know what virus or what strains of a particular virus are responsible for the damage caused by this disease. Up to the present our knowledge regarding this point is incomplete. Middleton and his co-workers have initiated a series of studies designed to provide this information. The results of this investigation will obviously be of immense importance to the plant breeding program.

One cannot help being impressed by the fact that the solution of a complex problem such as we have under consideration can only be reached by the combined efforts of a group of specialists. It is not a problem that can be solved individually by the pathologist, the entomologist, the horticulturist, or the plant breeder. However, by an intelligent fusing of the information acquired by these various specialists there is hope that some relief may be expected.

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